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ABSTRACT

Because it is essential that, wherever applicable, new technologies be integrated with the developing public broadcasting system, the Corporation for Public Broadcasting is committed to a policy which will seek to have communication satellites utilized to the fullest for the benefit of all engaged in noncommercial broadcasting and communications. A number of issues which arise from this relationship should be addressed: the use of multiple channels and local autonomy, flexibility of regional configurations, growth and coverage, signal quality, cost, and reliability. The public has a real and direct interest in the potential cost-savings and flexibility inherent in satellite technology, and can now receive a partial return on their more than $25 billion investment in the space program in the form of first-class interconnection systems for public television and radio. (VT)

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PUBLIC BROADCASTING & COMMUNICATION SATELLITES

A report from the Corporation for Public Broadcasting

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PUBLIC BROADCASTING & COMMUNICATION SATELLITES

A REPORT FROM THE CORPORATION FOR PUBLIC BROADCASTING

The Corporation for Public Broadcasting is a private, nonprofit corporation established to implement the objectives of the Public Broadcasting Act of 1967. CPB receives public and private funds and, in the public interest, disburses them to noncommercial educational broadcast licensees and others

(1) to assist in the development, production, and/or acquisition of high quality programs to be made available to licensees,

(2) to assist in the distribution of such programs so that all licensees who choose to use them may do so, and

(3) to enhance each licensee's ability to serve the local public interest with communication services designed to meet locally determined needs and objectives.

This report provides basic information on the promise CPB believes satellite communications holds for public broadcasting.

WESTAR 1 satellite

The technological explosion of the past decade has generated great pressures on broadcasters to utilize new techniques as quickly as possible. Cable television, video cassettes and video disks, multiple terminals for computers, lasers, and wave guide technology are all subjects of great interest to this field. It is essential that, wherever applicable, these new technologies be integrated within the developing public broadcasting system.

We are now entering the era of domestic communication satellites. This new technology is destined to revolutionize domestic communications. The Corporation believes in this new development, and it is committed to a policy which will seek to have communication satellites utilized to the fullest for the benefit of all engaged in noncommercial broadcasting and communications.

For a large and heterogeneous society, increasingly dominated by television and radio, there can be few issues of greater importance than providing responsive public broadcasting services. Satellite technology can contribute to this goal by providing a reliable interconnection of high quality, capable of delivering multiple programs to each station.

The use of this new distribution technology is fully in line with the objectives of the Public Broadcasting Act, and the mission of public broadcasting. In carrying out its service to many different audiences—some large and nationwide, some highly specialized—public broadcasting needs to make effective use of technology that will allow it to reach these audiences when, and where, they can best use the program material.

CPB has been deeply involved with developing the use of satellite technology for many years. The Corporation was an early sponsor of experiments that brought educational and social communications services to public broadcasting. In 1969, CPB and NASA carried out the transcontinental interconnection experiment (TIE) using NASA's ATS-3 satellite. In the ATS-F program in the early 1970s, CPB & HEW were chiefly responsible for the inclusion of the social and technical experiments which came to fruition in 1974 in Alaska, Appalachia, and the Rocky Mountains. Today CPB is active in NASA's experimental CTS satellite program, exploring new frequency bands, as well as in the preparations for the 1979 World Administrative Radio Conference.

The American people have invested more than $25 billion in the space program. Communication satellite technology is derived from that investment. The public thus has a real and direct interest in the potential cost-savings and flexibility inherent in satellite technology, and can now receive a partial return on their investment in the form of first-class interconnection systems for public television and radio.

In addition, there are important cost-savings to be realized. The current congressional appropriation for CPB is a generous and substantial increase over earlier levels of support, but it still is only part of the support which public broadcasting requires. Every dollar spent on interconnection is a dollar taken away from program production and the further development and expansion of broadcasting services.

MULTIPLE CHANNELS, LOCAL AUTONOMY

In public broadcasting, local station autonomy is paramount. Autonomy guards against the possibility of any centralized domination, whether it be in the area of programs, scheduling, or financing.

In the existing ground interconnection system, each station is limited in terms of national program selection, since at any time only one program can be sent over the line. This is particularly noticeable on those occasions when some important event eclipses the national schedule. During the Watergate hearings, many stations who wished to show the hearings at another time, or not at all, were deprived of the original national schedule in real time.

With satellite interconnection can come the option to provide additional channels, from which the station can choose the programming it would like to show.

The FCC has authorized several companies to launch communication satellites, all of them capable of handling video and audio channels. The use of this service requires the building of ground receiving stations as close to the public station as possible. Most public television stations will be outfitted initially to select any two of the four available channels, while radio stations will have at least four high fidelity channels.

Since a ground station is capable of receiving as many channels as the satellite can carry, this will mean that public broadcasters will have access to several nationally distributed programs, as well as programs from other sources who have leased space on that satellite.

The nature of satellites permits another interesting possibility. Any station having access to a transmitter can originate programs, and send them to the satellite for retransmission to all of the receivers pointed at that satellite. This can open the door to a great diversity in the programming available to the station. This diversity—more than was ever envisioned by the founders of public television—leads toward increased choice and freedom for the local broadcaster.

FLEXIBILITY

For a number of hours each week, the existing terrestrial interconnection is broken into regional configurations. Thus, the Rocky Mountain states, the Eastern Educational Network, the Southern states (SECA), the Western Educational Network, and the Central Educational Network can distribute regional programming among their states. It is clear that these groups of states share common problems and interests because of their location, but what of those states or regions that share other interests but are not geographically adjacent? Big cities should be able to talk and share experiences with other big cities: areas with high minority population should be able to talk to other similar areas; likewise farm states to farm states; cotton producers to cotton users; states bordering Canada to each other; California to Florida on orange growing problems; etc. Satellites permit configurations based on common interests regardless of geography.

GROWTH, COVERAGE

At the beginning of 1970, there were 189 public television stations on the air, and 97 qualified public radio stations. Today, there are 264 public television stations, and 180 public radio stations. The trend is clear—more and more stations serving an increasing number of Americans. As public radio and television continue to grow and add stations, most will be in outlying areas—rural locations, and areas otherwise difficult to reach.

1958: SCORE
The first true communications satellite, it rebroadcast to earth an on-board tape recording of President Eisenhower's Christmas message.

1960: ECHO
The metallized skin on this 100-foot diameter plastic balloon passively reflected back to earth signals beamed to it from a huge ground antenna.

1962: TELSTAR
First nongovernmental satellite, Telstar was built for AT&T and carried live television across the Atlantic for the first time.

1962: RELAY
More powerful than Telstar, the elliptical-orbit Relay expanded knowledge of TV, data and facsimile transmission over long distances.

1963: SYNCOM
First communications satellite in synchronous equatorial orbit. Syncom had the same rotation period as the earth's, and therefore appeared to be stationary in the sky.

Using ground interconnections to bring programs to those stations would be a difficult task. But for satellites, geographical barriers do not exist. Most ground locations are essentially equal in their ability to receive signals from space, and connecting a new station into the system means only adding a receiving antenna at that location.

Public broadcasting's plan for the future includes reaching all citizens with at least one public broadcasting television and radio signal. Presently, 75-80% of the nation is within reach of a public television signal, while public radio reaches 65%.

Receiving antenna at an outlying public television station

For situations where density of population does not justify building a standard radio or television station, the Corporation for Public Broadcasting has envisioned substituting very small transmitters (of approximately 10 watts) fed by a satellite receiver, so that nationally produced programming will be made available.

With a satellite system, most offshore and Alaskan stations can be interconnected for the first time. Hawaii, Puerto Rico, the Virgin Islands, and the Alaskan stations presently receive a delayed service by videotape. Existing cables to the offshore points cannot carry video information. Satellites will make those interconnections an everyday affair, and can bring these areas into the mainstream of American life with respect to communications with the rest of the nation.

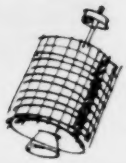
SIGNAL QUALITY

The quality of each station's video or audio signals depends on a multitude of factors beyond the control of any broadcaster. In the present distribution networks, some stations receive a signal that has traveled only a few miles, and through a minimum of electronic equipment. On the other hand, many stations receive signals that have traveled more than three thousand miles, with the degradation which affects signal quality over so long a trip. The hundreds of repeaters through which these signals must pass, and thousands of miles of land lines, degrade the signal, sometimes quite noticeably. In contrast, a satellite system involves only one repeater, while most of the miles traveled occur in the vacuum of space, and produce only limited impairments.

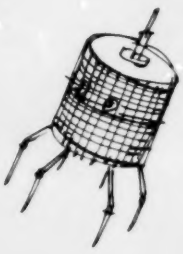
In the context of satellites, it is possible to predict accurately the quality a signal will have. Experience dictates that the quality will be much improved.

For radio, this improvement will be more than just a quality improvement. The existing radio interconnection network is limited to standard telephone lines which are incapable of transmitting high fidelity or stereo signals. Such difficulties do not exist in the satellite system, and present plans call for high fidelity stereo service to each station.

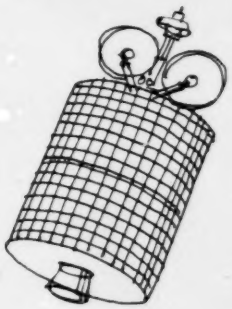
1965: EARLY BIRD
Known also as Intelsat I, this geo-stationary satellite was the first space achievement of the International Telecommunications Satellite Consortium that has since made global satellite communications an everyday reality.



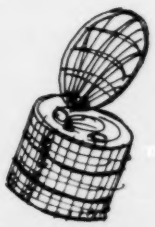
1966: ATS-1
Multi-purpose high power VHF and microwave satellite. Used in experiments in Alaska and U.S. for TV and radio transmission.



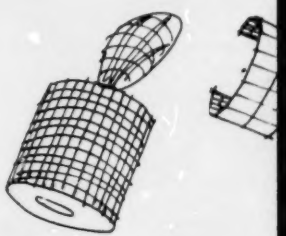
1971: INTELSAT IV
Vastly expanding the capacity of over-ocean satellites, four Intelsat IV's in equatorial geostationary orbits over the Atlantic, Pacific and Indian Oceans now serve more than 50 nations around the world.



1972: ANIK
First geostationary synchronous satellites orbited for domestic service, two Aniks now tie Canada's population centers to each other and to the nation's farthest outposts.



1974: WESTAR I
Western Union's new satellite system is providing domestic USA telecommunication relay service. It is the first venture of its type under entirely private auspices.



COST

It now seems clear that the total system cost of providing satellite interconnection for public television will be competitive with the existing system. For radio, costs will be higher, but this is due to the greatly expanded nature of the radio system compared to its limited present state — multiple stereo high-fidelity programs vs. a single low fidelity mono system.

For some time it has seemed apparent that satellites could offer cost-savings over terrestrial alternatives. This principle, however, must be examined in context.

Public broadcasting receives a favorable rate for its two interconnection systems compared to the tariffs paid for similar systems used by commercial broadcasters. Although the terrestrial system has some drawbacks, it has provided a highly acceptable service for some years now.

When we began detailed investigations to determine if any cost-savings were possible by moving to satellites, we determined that savings were possible if public broadcasting could make use of the latest technology in earth stations, and negotiate a favorable satellite tariff with a common carrier. In addition we found financial considerations other than just improved costs.

We found that satellite service could be negotiated over time periods, 7-10 years in length, so that rates would not escalate as inflation might dictate, and furthermore, predictability of expenses was possible — allowing the type of planning in an industry that operates on production schedules of 12-18 months requires. All of these factors provide a uniquely attractive situation for public broadcasting.

Since the Public Broadcasting Act of 1967 states:

Nothing in the Communications Act of 1934 as amended, or in any other provision of law shall be construed to prevent United States communications common carriers from rendering free or reduced rate communications interconnection services for noncommercial educational television or radio services subject to such rules and regulations as Federal Communications Commission may prescribe. 47 U.S.C. Sec. 396 (h).

CPB has been free to approach satellite carriers and negotiate favorable rates. After discussion with a number of carriers, CPB has agreed to accept satellite service on three transponders on the Western Union Telegraph Company's WESTAR satellites — with options on additional or occasional service — for a seven year period.

RELIABILITY

In terms of reliability, each station aims at minimizing its outages. While the responsibility for such outages resides with the common carrier providing the service, even the existing techniques for fault detection over thousands of miles of circuits and hundreds of repeaters is not foolproof. Outages are experienced daily in the system, and public broadcasting engineers must constantly check the signal quality to determine when repairs are needed.

While it is impossible to predict that satellite interconnection systems will not have outages, the fact that only one repeater per channel is involved is important. That repeater has been engineered to operate in an environment where it cannot be repaired and so it has built-in redundancy, and uses components of higher quality than any of its terrestrial counterparts.

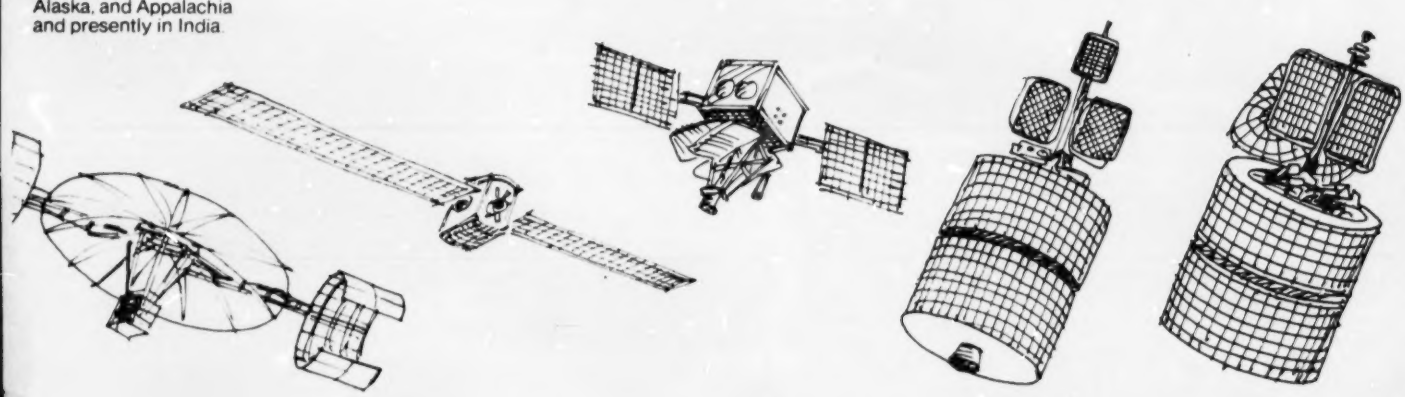
1974: ATS-6
Most powerful communication satellite ever orbited. Conducted satellite broadcasting experiments in Rocky Mountains, Alaska, and Appalachia and presently in India.

1975: CTS
Joint NASA and Canadian government. First satellite to test out higher frequency bands.

1975: SATCOM
RCA's domestic commercial satellite uses 3-axis stabilization with its fold-out solar array.

1975: INTELSAT IV-A
INTELSAT's newest satellite with capacity of over 6,000 voice channels and 2 TV channels.

1976: COMSTAR
Launched and owned by COMSAT and leased in its entirety to AT&T.



SATELLITE

A man-made object put in orbit around the earth.

COMMUNICATION SATELLITE

A satellite which carries electronic equipment capable of receiving signals from earth, and retransmitting those signals back to a desired area.

PERIOD OF A SATELLITE

The time it takes a satellite to complete one revolution of its orbit.

FREQUENCY

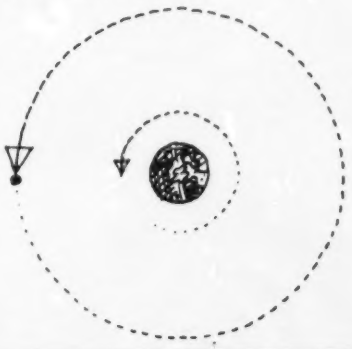
The number of waves of electrical energy sent out each second. Usually expressed in cycles per second, or hertz.

BANDWIDTH

A measure of the capacity of an electronic communication system.

SYNCHRONOUS SATELLITE

An artificial satellite whose orbit is located 22,000 miles from earth, so that its period (of revolution) is 24 hours, or synchronized with the earth's daily rotation.



GEO-STATIONARY SATELLITE

A synchronous satellite whose orbit is in the plane of the equator so that it not only has a 24 hour period, but also has no north-south motion and appears to remain stationary over one point on earth.

MEGAHERTZ

A measure of frequency equal to one million hertz, where one hertz is one cycle/second of electronic energy. (Example: household current in the United States is 60 cycles/second or 60 hertz.)

LOOK ANGLE

The antenna at each earth station is pointed at the satellite with which it is working. The angle above the horizon of that antenna is called its look angle. The higher the look angle, the lower the potential interference to that station.

DISTRIBUTION SATELLITES

Medium-powered satellites which can send signals (usually TV) to earth stations costing between $30,000-$300,000.

COMMUNITY BROADCAST SATELLITES

High-powered satellites which transmit signals that can be received by inexpensive installations affordable by communities, but not by individuals. ($3,000-$30,000).

DIRECT BROADCAST SATELLITES

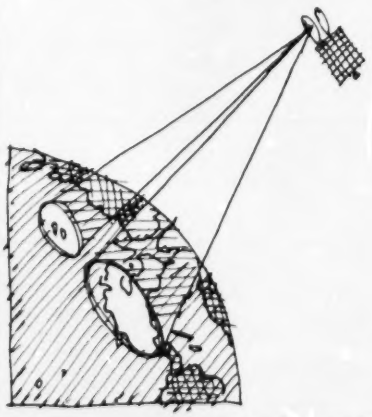
A satellite which can send a signal intended for direct reception by the public.

EARTH STATION

Equipment located on earth used for the transmission and/or reception of signals to a communication satellite.

FOOTPRINT

The area on earth within which a satellite's signal can be received is said to be 'in the footprint.'



TRANSPONDER

A piece of equipment on a satellite which receives the signal from an earth station, changes its frequency, amplifies it, and retransmits that signal back to the earth.

Each transponder on a satellite operates on a different frequency, and is capable of handling one television channel with audio.

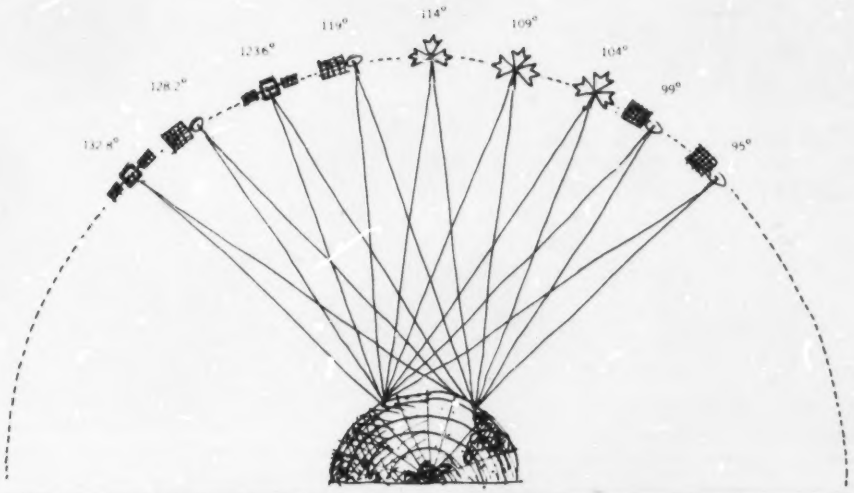
The radio spectrum assigned to satellites is 500 megahertz wide. Presently, each transponder is 40 megahertz wide, so that 12 transponders on a satellite occupy the entire band. Satellites that are cross-polarized can have 24 transponders.

CROSS-POLARIZATION

Electrical energy being transmitted by the satellite normally has its waves oriented either horizontally or vertically. When a satellite transmits both horizontal and vertical waves, it is said to be cross polarized, and thereby can reuse the entire radio spectrum—once horizontally, and once vertically.

CHRONOLOGY

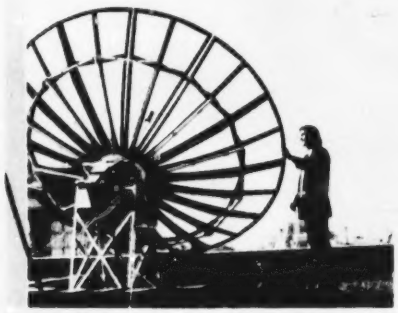
1945 Arthur Clarke proposes synchronous satellites.
1947 First microwave relay system inaugurated between Boston and New York.
1947 Transistor invented at Bell Laboratories.
1948 Commercial television network service started over Bell system.
1950 First cable television system started.
1954 First compatible color television broadcast.
1957 First artificial satellite launched.
1958 SCORE, first communication satellite launched by U.S.
1960 ECHO satellite launched for reflected communications.
1960 COURIER, first active communication satellite launched by U.S.
1962 COMSAT Corporation formed by Act of Congress.
1962 Telstar I launched, first non-government communication satellite.
1962 David Brinkley delivers European news from Paris to American viewers through Telstar.
1962 Relay satellite launched by NASA.
1963 Syncom II launched, first synchronous communication satellite.
1963 COMSAT incorporated.
1964 Intelsat consortium established.
1965 Early Bird launched, first commercial communication satellite.
1965 First commercial TV between U.S. & Europe introduced by COMSAT.
1965 MOLNIYA I, first domestic satellite launched by Russia.
1966 ATS-I satellite launched by NASA.
1967 COMSAT launches first Intelsat II satellite.
1967 NASA launches ATS-3 satellite.
1967 ATS-I and two Intelsat II satellites couple to provide worldwide two-hour satellite broadcast sponsored by EBU.
1968 COMSAT launches Intelsat III for start of its global system.
1969 Apollo II moonwalk is seen by one out of every seven people on earth via communication satellites.
1971 COMSAT launches first Intelsat IV expanded global satellite.
1972 Canadian Government launches ANIK-I for domestic communication.
1974 WESTAR I, first U.S. domestic communications satellite launched.
1974 NASA launches ATS-6, most powerful communication satellite ever built.
1974 Symphonie communications satellite launched by Germany and France.
1974 The Rocky Mountains, Appalachia, and Alaska conduct satellite broadcasting experiments using ATS-6 and low-cost 10-foot terminals.
1975 ATS-6 goes to India to conduct historic satellite broadcasting experiments.
1975 Intelsat IV-A launched.
1975 NASA and Canadian government launch CTS.
1975 RCA SATCOM launched.
1976 COMSAT launches COMSTAR I satellite for AT&T.



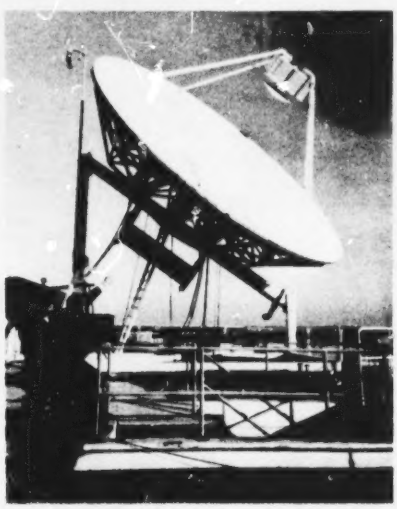
SATELLITE PLACEMENT

For the United States, Alaska and Hawaii, the usable orbit for communication satellites lies between 95° and 135° west longitude (approximately). Even though these satellites are spaced 4.5° to 5° apart, this allows at least nine satellites to serve these areas simultaneously using the presently allocated frequency bands. If all channels on these satellites were used to carry television (which they are not), this means that capacity for 156 channels of television would be available in this band. As technology advances and new frequency bands become available, the orbital arc from 95° to 135° can be reused many times over.

Another method for reusing the limited orbital arc is to use spot beams which cover only a limited area. A second satellite operating from the same orbital slot can serve another area. For example, the WESTAR 1 satellite at 99° now has a beam pattern which covers the United States. From that same location, using the same frequencies of operation, another satellite can serve Latin America.



ATS-6 receiver



Typical satellite receiver ground station.

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